

Effects of confining pressure and temperature on mixed-mode (I-II) fracture toughness of a limestone rock

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Abstract: Studying fracture toughness behavior at elevated temperatures and confining pressures is valuable for a number of practical situations such as hydraulic fracturing used to enhance oil and gas recovery from a reservoir, and the disposal or safe storage of radioactive waste in underground cavities. Mixed-mode (I-II) fracture toughness under simulated reservoir conditions of high temperature and confining pressure was studied using straight notched Brazilian disk (SNBD) specimens under diametrical compression. Rock samples were collected from a limestone formation outcropping in the Central Province of Saudi Arabia. Tests were conducted under an effective confining pressure (σ_3) of up to 28 MPa (4000 psi), and a temperature of up to 116°C. The results show a substantial increase in fracture toughness under confining pressure. The pure mode-I fracture toughness (K_{IC}) increased by a factor of about 3.7 under a σ_3 of 28 MPa compared to that under ambient conditions. The variation of K_{IC} was found to be linearly proportional to σ_3 . The pure mode-II fracture toughness (K_{IIC}) increased by a factor of 2.4 upon increasing σ_3 to 28 MPa. On the other hand, K_{IC} at 116°C was only 25% more than that at ambient conditions. Some ductile behavior was displayed by the rock samples at a high temperature and confining pressure.